Date: March 16, 1998
Subject: PM2.5 Monitoring Needs

AGENCY Panel

BAAQMD- Gary Kendall

- *Continuous 'FRM PM2.5 monitor* that produces at least hourly PM2.5 concentrations, and agrees with the 24-hour average concentrations produced by a gravimetric PM2.5 FRM;

- *Continuous automated PM2.5 speciation monitor* that provides nitrate, elemental carbon, organic carbon, and sulfate concentrations at least hourly;

- *Continuous nitric acid and ammonia monitor(s)* that provide at least hourly concentrations of ammonium nitrate precursors.

USEPA/OAQPS- Rich Scheffe

- *Time, phase and size resolved chemically speciated aerosol data* for air quality model diagnosis, emissions evaluation and support to the health effects community

- *Comprehensive air chemistry data* that enables one to understand formation, maintenance and removal processes for oxidants and related secondary aerosol species, and supporting deposition (nutrients, acids, HAPs) and ambient exposure assessments.

- *Technology transfer of advanced measurement systems*, procedures and expertise that meet the prior objectives to the greater (e.g., Districts and Local agencies) air quality community.

SCAQMD- Mel Zeldin

By 'future needs' I am looking beyond the current EPA directives, and pointing toward those aspects which will improve automated efficiencies and provided key ambient data to support future SIP development.

- *Automated FRMs/FEMs.*
  Current approaches for mass measurement are very labor intensive, both from field filter handling and laboratory analysis. Automated devices, if proven to be accurate for PM2.5 can substantially reduce field and lab labor costs associated with such measurements, and
  possibly reduce artifact biases by reducing the time frame to make the measurement.

- *Continuous Speciated Monitors*
  Current methods provide for lab analyses of filters on a 24-hour basis. For modeling and planning purposes, continuous monitors for PM2.5 species will provide greater time resolution of key components, such as nitrate, sulfate, carbon. Development of such monitors will greatly improve our ability to develop better models to support SIP development.

- *Special Precursor Monitors*
  In South Coast, ammonium nitrate is the key constituent to PM2.5. Again, for modeling and planning purposes, having short time-resolved measurements of both ammonia and nitric acid gases will greatly improve model and predictive capabilities. Development of such instruments is important.

- *Budget and Manpower*
  In the shorter term, the ability to meet the existing requirements by EPA will involve considerable resources because of the labor-intensive aspects of PM2.5 monitoring. Adequate resources must be committed to assure a successful program, and additional resources are needed to meet the future monitoring needs. Overall, however, if more automated methods are developed, there may actually be resource savings over current needs, while still providing for those additional measurements, as indicated above.

San Joaquin Valley APCD- Dave Jones

- Adequate network data (FRM/FEM) to *determine attainment status* for the PM2.5 NAAQS.

- A network that will act as a backbone during comprehensive field studies.

- A comprehensive network of *real-time PM2.5 instruments* to assist in air quality and ag-burn forecasting.

- Monitoring network that provide baseline *data for planning comprehensive* PM studies.

- Representative exposure sites to provide data for determining population exposure.

- Speciation data suitable for use for analyzing source contributions.

- Monitoring data suitable for tracking control strategies via trend analyses.

- Network data to assess transport of PM2.5 between regions.

- The network will be useful in any future Regional Haze Program.

TSD Emission Inventory Branch- Beth Schwehr

To validate and reconcile emission inventory (EI) data and ambient data, and to support source apportionment analysis:

- Ambient PM samples need to be *size segregated and chemically speciated within each size fraction*. The size segregation should include PM10, PM2.5, and PM1.0 to match EI speciation.

To support modeling and advance our understanding of the sources and formation of secondary particulate:

- *PM speciation* needs to include ion, elemental analysis, and speciation of the organic carbon constituents. This includes collection and speciation of semi-volatile organics, which may include toxics such as polycyclic aromatic hydrocarbons (PAHs).

- Ideally, all *speciation would utilize an integrated approach*, referred to as "complete picture" speciation, which involves collecting and speciating organic gases, semi-volatiles, and particulates in a coordinated way from the same sampling site. More realistically, it would be desirable for at least a few key sites to use this type of approach at a few intervals. Alternatively, perhaps some special monitoring could be conducted periodically using this approach, to supplement the routine monitoring.

- *Speciated particulate matter data* is needed at a sufficient number of representative sites for each month and season of the annual average within each non-attainment air basin or modeling domain. These data are needed to perform EI validation and reconciliation with air quality data and for modeling analysis. This effort would require an in-depth statewide characterization over a 1-2 year

period that included speciated 24-hour PM10 and PM2.5 from several sites in each of the major non-attainment areas. Subsequently, speciated samples would be needed from one site in each major non-attainment area (~5-10 total sites) on an on-going basis to track trends.

ARB/TSD/Modeling- Karen Magliano

- *Enhanced temporal resolution*.
  The daily sampling planned for a number of sites is great. From an annual standpoint the 1/3 or 1/6 day is fine statistically, but for episodic, our daily sampling from IMS really pointed out how the 1/6 sampling misses exceedances and particularly does not provide info on the buildup and dissolution of episodes. We also saw considerable variation in PM concentrations within a day which were very illuminating. The more continuous, species specific methods we can get the better for nitrate or carbon the better. In addition, both John Watson and Will Richards think that good relationships between light scattering and PM2.5 can be obtained with the appropriate relative humidity corrections (see #5 below).

- *Speciation* (and more speciation).
  The IMS95 results from the saturation sampling network suggested that a reasonable tradeoff would be fewer sites, but more complete speciation of the sites that remained. The more advanced speciation techniques, particularly for organics such as being done by Glen Cass really advance our understanding of the contributing sources.

- Measurement of *precursor species such ammonia and nitric acid* allow us to construct material balances and understand the limiting precursor.

- *Adequate number of sites* to determine background concentrations and composition.

- As companion measurements, *more accurate methods for low wind speeds and relative humidity, and accurate recording of the occurrence of fog* aid in interpreting the particulate measurements

Research Division- Randy Pasek

- Continuous monitoring of sulfate, nitrate, PM10 and PM2.5 mass, and organic and elemental carbon measurements.

- Development or proving of a PM speciation measurement method that will work in an urban environment. Nitrates measurements have not been adequately proven by any monitor in southern California.

- The single particle analyzer developed by UCR shows promise as valuable monitoring tool (at the very least for special studies). Some effort is needed in making the instrument more practical for routine ambient measurements. Monies for developing efficient methods for handling the large amounts of data are needed and to make the instrument less complex so that someone other than a postdoc is needed to operate the instrument.

- Fundamental research is needed on gas phase to particle conversion (particularly secondary organic formation) so that appropriate monitoring methods can be develop to measure the appropriate precursor and intermediate compounds.

Technical Support Division- Debbie Popejoy

Data for improved source attribution analyses:

- Elemental and ionic species analyzed at a larger number of sites, useful for receptor modeling

- Daily diurnal variations (by hour, or minute if possible) to help identify sources contributing to the highest concentrations of the day

- Profiles of elemental and ionic species for major sources

Provide ambient data to fill in current knowledge gaps:
- Intensive (daily) monitoring in the winter in areas of heavy wood burning

- A split of total carbon into organic carbon vs. elemental carbon for all sites with high concentrations

- Identification and quantification of individual organic species
  Profiles of individual organic species for major sources

Co-locate surface and aloft (up to 2-3 km mean-sea-level) particulate measurements with meteorological, criteria pollutant, and hydrocarbon measurements.
- Provide an adequate spatial and vertical resolution for particulate measurements, especially along potential transport corridors.

- Provide a 3-dimensional picture of meteorology and air quality.

Collect meteorological data such as wind speed, wind direction, surface mixing height, temperature, relative humidity, and rainfall.

Collect speciated gaseous and semi-volatile hydrocarbon data to determine air mass origin and age.

Technical Support Division- Andrew Ranzieri
Modeling and Data Analyses
- Where and when do exceedances occur?

- What are the spatial and temporal variations in PM?

- What is the spatial representativeness of a given measurement?

- How adequate are existing PM monitoring methods, and how do we ensure the monitors are operated within design parameters?

- How much PM10 is PM2.5?

- What is the PM size distribution?

- What are the chemical components of PM?

- What are the concentrations of PM precursors?

- What are PM concentrations aloft?

- What meteorological conditions are associated with exceedances?

- What are natural background concentrations?

- What is the relationship between PM and ozone chemistry?

Emission Reconciliation
- How well do ambient and emissions data compare?

- Can day-specific source contributions be detected in ambient air?

Control Strategy Evaluation
- What are the specific sources which are contributing to PM exceedances?

- What is the zone of influence of these sources?

- Are exceedances local or regional in nature, or a combination of both?

- Which PM components should controls be focused on?

- Will the same strategies be effective for both the annual and the 24-hour standards?

Research Division- Tony VanCuren

Optical instruments such as nephelometers, transmissometers, aethelometers, COH, etc. permits determining the optical characteristics of the aerosols and linking those characteristics to the chemical composition of the PM2.5;

For visibility, the benefits of optical monitoring are:
- Determining attainment status for State Visibility Reducing Particles (VRP) Std.

- Crediting the visibility benefits of PM control programs toward VRP attainment.

- Understanding source-area contributions to haze in Federal Class I areas, where visibility improvements are required under the new Federal Regional Haze Regs.

Real Time optical measurements provide:
- A short-time resolution measurement of fine particle concentrations - useful for interpreting time-integrated filter samples and for analyzing the build-up and decay of peak PM episodes.

- Data showing the diurnal cycles of PM, which can be very useful to source apportionment studies, since many PM sources have distinct diurnal and seasonal fluctuations in emission rates.

- Tracking growth of secondary particles, especially nitrates.

- Tracking humidity-related particle growth (condensation).

- Tracking optical impacts of aerosols on ozone-forming UV flux and possible links between organic aerosol chemistry and ozone formation.

Research Division (Health Related)- Dane Westerdahl

To monitor particles *people* are exposed to:

- Physical parameters—mass, size and number
- Time resolution—hourly or continuous
- Size resolution—0.1, 1, 2.5 and 10 micron
- Chemical speciation—nitrate, sulfate, ammonium, acidity, total+organic C
- Locational resolution—study site/individuals + homes (usually small areas)
- Duration of monitoring—months/years
- Methods equivalency—proven between various metrics
- Specific requirements—portable, small units for personal + indoor studies
- Continuous monitors—calibrated surrogates for routine mass monitors

To monitor particles *populations* are exposed to:

In addition to the above:

- Time resolution—daily or better
- Locational resolution—community representation (not just highs and lows)
- Duration of monitoring—prolonged

<u>Research Division (Population Exposure)- Peggy Jenkins</u>

- Need more *personal and indoor exposure monitoring*, accompanied by detailed source apportionment of those samples.

  Reason: The EPA/ARB Particle TEAM study conducted in Riverside and other personal particle exposure studies have shown that ambient monitoring station particle data do not correlate well with actual exposures. Personal exposure levels are often much higher than levels measured at ambient stations, and the relative contributions of ambient sources differ due to personal activities, indoor sink effects and other removal mechanisms, and so on. Need to identify the major contributing sources to personal exposures in order to develop the most effective risk management program. This requires speciation, SEM, etc.

- Need improved, *standard accepted particle samplers* for indoor and personal exposure monitoring. Must be quiet, lightweight, accurate, etc.

  Reason: Personal integrated particle samplers currently come from one manufacturer with unreliable quality control. Indoor particle samplers are either a) personal samplers that are stationary, or b) a

variety of large, expensive, real time samplers just beginning to be used in indoor applications, none of which have been thoroughly tested or proven for their performance in indoor environments. EPA (and/or CARB) specifications for personal and indoor samplers would provide a useful standard and assure at least a minimal level of performance and quality.

- Need greater *ambient saturation sampling* in residential neighborhoods, business areas, school yards, and other locations where people spend their time.

  Reason: Per PTEAM study results and results from similar studies, ambient station data often do not correlate well with samples collected outside of residences in residential neighborhoods. Levels of particles can be much higher or much lower in surrounding areas than indicated by ambient station data.

Research Division (Health)- Karlyn Black

- At a minimum, *daily mass measurements* to support epidemiological studies which often look at daily and even hourly doctor, clinic, hospital and emergency room visits as well as design clinical and animal exposure studies. Exact mass measurements would be nice but *some surrogate* measurement that could be quantitatively used to accurately calculate mass might do for health studies.

- *Hourly mass measurements* need to be employed for use in health studies. Either exact mass measurements *or some surrogate* measurement that could be quantitatively used to calculate mass would do. These data would be very useful for epidemiological studies which often look at hourly doctor, clinic, hospital and emergency room visits, but also for designing human clinical and animal exposure studies.

- *Daily PM speciation* would be useful initially but might prove to be a resource and data management challenge if carried on too long term. Medium term, i.e. say 5 years, of intensive monitoring and speciation might prove to be enough to establish a historical database that is sufficiently refined as to be useful in making some educated and accurate assessments of exposure

- *Spot Speciation Studies* on a periodic basis to check for consistency with the existing data base as well as to check for variations that may arise due to changes in population growth and location, and/or contributing sources. This information is of value for epidemiologic studies but has its greatest value in its necessity for designing human clinical and animal exposure studies.

- If we were really good in our initial speciation characterization, and solid correlations could be found between different PM species, then it might be possible down the road to measure only a few species quantitatively.

- Hourly carbon measurements (Organic, Inorganic and Total) in areas with both primary and secondary fine PM problems. This information could be used to support epidemiologic studies as well as design clinical and animal exposure studies.

- *Fully speciated hourly data*. If it were possible from our initial speciation characterization to develop solid correlations it might be possible to measure a few species quantitatively on an hourly basis and calculate the species of interest to health researchers as needed. This information would be very useful for assessing exposure in support of epidemiologic studies as well as in designing clinical and animal exposure studies.

OEHHA- Michael Lipsett and Bart Ostro

- Need to make sure that, for purposes of epidemiological studies, PM2.5 and PM10 monitors are co-located in order to better assess the relative effects of coarse and fine particles in relation to morbidity and mortality.
- Need to have some monitors dedicated to daily measurement for extended periods in conjunction with specific time-series health studies.
- Need to have some flexibility in assigning monitors to specific locations in order to be able to provide assistance on epidemiological studies funded by non-ARB sources and/or for emergencies (e.g., major wildland fires upwind of populated areas).
- Should have source apportionment analysis (by chemical mass balance) of PM2.5 by season in different locations. This would be important in order to target appropriate location-specific emissions reductions.
- Should have adequate monitoring coverage of areas that include both high and low PM2.5/PM10 ratios.
- Would recommend that ARB provide guidance to individual health researchers using real-time PM monitors on the reliability and validity of real-time PM2.5 monitoring. This might involve additional special investigations.
- Would suggest also special studies assessing other PM cut sizes (including ultrafines) and their co-variation with PM2.5, which could be relevant in future health investigations.

STAKEHOLDER Comments

California Council for Environment and Economic Balance- Cindy Tuck (partial list)

- Assurance that adequate speciation monitoring data is obtained not just mass
- Assurance that meteorological data is obtained
- Placement of monitors to represent human exposure
- Maintaining a sufficient sampling frequency to ensure a robust data set

Western States Petroleum Association (WSPA)- Cathy Reheis (draft)

Additional comments/needs are still being identified by their membership.

- Need to have the ability to provide as much information as needed to be utilized for compliance and relating to health based studies.
- Need a lot more information for cogent PM policy. Otherwise have broad-based approach without understanding relationship to exposure and risk reduction.
- Want to look at the network for providing as much data as we can to really understand what we are seeing in the atmosphere over time.
- Need to recognize that routine networks will not be adequate for modeling evaluation.
- Need to develop a conceptual understanding of what's going on so we can know causation link to other things and draw conclusions from a PM episode. Need cross linkage similar to ozone/PAMS network.

- The question has not been answered yet, what are the causative agents? If we are seeing mortality, we must have a better handle on what is PM fine. Many believe the problem is not all PM related.

- Need to fully understand relations between outdoor community monitors and indoors including to personnel and ability of data to really be used for health orientation studies so we know what, if anything is the real bad actor and look at controlling it.

- Need speciation of components including chemical speciation (i.e. organic fraction) and size - are particles a mixture (i.e. not pure nitrate)?

- Need concurrent meteorological measurements, surface and aloft and measurements of the gaseous side to get speciation of organics, ammonia, nitrates, and aerosols. Just having PM data on a filter won't tell the whole story. We need to know where the stuff came from. Relativity humidity also needs to be measured for fog and visibility issues since some of the high PM episodes occur with low wind speed (less than 1 m/s) some of the meteorological sites should have sonic anemometers to measure wind under low wind speed conditions.

- Spatial representation is important, but so is temporal representation. During certain times of the year one type of source may be influencing, but another time of the year, a different type of source may be dominate. Data analysis of past studies should be completed to indicate at what times of the year PM2.5 is as at a maximum and what source potentially impact the maximum. The area and makeup of the maximum will be different throughout the year. The monitoring network should reflect that difference.

- Need to understand oxidizing agents.

- Need visibility measurements (i.e. transmissometers) to look at surrogates for physical monitoring so we can have a reasonable relationship for measuring visibility and fine aerosols.

- Need to make certain that future monitoring will adequately differentiate emissions between stationary and mobile emission sources. May require special analytical and/or monitoring methods and may necessitate that we also monitor in areas that would have little impact from mobile sources in order to get background values for stationary source emissions.

- Need to have new monitoring technology that does not rely on costly use of filters and analysis. Would like to see "real time" type of measurements type ensure that technology does not results in significant positive or negative artifact formation. This type of methodologies may replace or compliment the present filter measurement technologies used in the Federal Test Method and IMPROVE type monitors.

- Is the network going to be big enough given the additional EPA-funded monitors to give us the information we need? Placement of enough of the needed measurements throughout the valley will be important to better document the complex flow within the valley.

- On the westside of Kern County, we need to be able to differentiate between our stationary sources and agricultural sources (i.e. fugitive dust emissions generated by plowing, seeding, fertilizing, cultivating, and harvesting). Fugitive dust emissions mainly come from driving on dirt roads, which are pretty consistent day by day. Ag emissions are more from working directly with the soil and may have more episodic impact on any PM2.5 monitors set up on the westside.